

Section 104.03 D. Payment will include disposal of excavated material, and the furnishing, placing, and compacting of the aggregate.

- d. Payment for prime, tack, and the bitumen in the mix used in the repair will be made at the Contract Unit Prices for those items.

## SECTION 409 HOT BITUMINOUS PAVEMENT QUALITY CONTROL/QUALITY ASSURANCE

### 409.01 DESCRIPTION.

This work shall consist of constructing one or more courses of bituminous pavement on a prepared surface for Quality Control/Quality Assurance (QC/QA) projects. The Contractor shall be responsible for process control, and shall perform the necessary testing to control the quality of the work. When specified on the plans the contractor shall develop a mix design.

### 409.02 MATERIALS.

- A. **Bitumen.** The bitumen shall meet Section 818 and will be of the type and grade specified in the Contract. Bitumen will be accepted as outlined in the Combined State Binder Group agreement for North Dakota. Samples will be obtained by the Contractor under the observation of the Engineer, and immediately handed over to the Engineer for shipping and testing.
- B. **Aggregate.** The Aggregate Gradation Master Range for the class of aggregate specified shall conform to the following requirements:

Sieve Size	Percent Passing
5/8 in.*	100
1/2 in.	90 – 100
No. 4	45 – 80
No. 30	10 – 35
No. 200	2.0 – 7.0

\*A tolerance of 2% in the amount passing the 5/8 inch sieve will be permitted providing all material passes the 3/4 inch sieve.

The gradation values listed are the extreme limits for design purposes. During Production mixture tolerance on all sieves, may fall outside the aggregate master range, except on the 200 sieve. The remaining physical properties, (lightweight pieces, P.I., fractured faces, etc.) for the class of aggregate specified, shall be as specified in Section 816.03 of the Standard Specifications.

### 409.03 EQUIPMENT.

Equipment shall be as specified in Section 408.03.

#### 409.04 CONSTRUCTION REQUIREMENTS.

**Contractor Quality Control.** Quality Control (QC) will be the responsibility of the Contractor. The Contractor will perform quality control sampling, testing, and inspection during all phases of the work at a rate sufficient to assure that the work conforms to the contract requirements. The Contractor shall have at least one person on the Project, at all times, that is qualified as a bituminous mix controller and one materials tester. Qualification requirements will be as outlined in the NDDOT Transportation Technician Qualification Program (TTQP).

**Quality Control Plan.** Prior to beginning work the Contractor will submit a “Quality Control Plan” to the Engineer. The Plan will contain: 1) the names and phone numbers of the individual(s) responsible for the Contractor’s quality control program; 2) a listing of the technician(s) responsible for the quality control testing; 3) an organizational chart indicating lines of authority (including names and phone numbers); 4) a summary of the qualifications of the Quality Control Technicians; and 5) details of the Contractor’s quality control plan addressing but not limited to the following items: 1) pit operations and methods used to control uniformity, reducing segregation, and efficiently utilizing the aggregate resources of the pit; 2) plant operations discussing proposed equipment (number of bins, plant type, etc.) and method of operations; 3) testing frequency and how this meets the intent of the Special Provision; and 4) discussion of how the Contractor’s quality control program will respond to the need for corrective action as defined in Section 409.04 O.2.

The Department will provide the Contractor with: 1) the names and phone numbers of the individual(s) responsible for project administration; 2) a listing of the technician(s) responsible for the quality assurance testing; and 3) an organizational chart indicating lines of authority (including names and phone numbers).

**Quality Control Laboratory.** The Contractor will furnish and maintain a Type C laboratory at the plant as specified in Section 706 of the Standard Specifications. Any other laboratory location must be approved by the Engineer. The laboratory will be furnished with the necessary equipment and supplies for performing the Contractor mix design if called for on the plans and for the contractor QC testing. During production of the aggregate, the Contractor may furnish a lab equipped with the necessary equipment to perform the following aggregate tests: bulk and apparent specific gravity, gradation analysis, lightweight pieces of aggregate, plastic index, and fractured faces. The Type C laboratory must be set up and ready to use before the paving operation begins.

The Contractor will provide a materials tester, as outlined in NDDOT TTQP, to perform all testing including all testing performed during aggregate production. The Contractor shall also provide testing equipment that meets the requirements for all tests called for by specifications.

**Engineer’s Laboratory.** The Contractor will provide an additional Type C laboratory to be used during actual mix production by the Department’s bituminous mix tester. The testing equipment will be provided by the Department. The lab will be set up at the plant prior to production of the bituminous mix and be made available to the Engineer for Quality Assurance testing. The Contractor and the Engineer will share the Triple Hammer provided for the Contractor’s lab.

A. **Pit Operations and Stockpiling of Aggregate.** Stripping of the pit and pit operations shall be conducted according to section During production of the aggregate,

the aggregate will be tested for gradation, plastic index, fractured faces, and lightweight pieces of aggregate. The testing frequency for gradation will be one test per 1,000 tons of material produced for each aggregate stockpile. The testing frequency for the plastic index, fractured faces, and lightweight pieces of aggregate will be the average of three random composite samples from the first 5,000 tons of material produced. If all three samples pass, the testing frequency will change to one of three samples tested for each 10,000 tons of material produced. If a sample fails, the remaining two samples will be tested and averaged for acceptance of that lot. The testing frequency will then revert to the average of three tests per 5,000 tons until all three samples pass, then one of three samples will be tested for each 10,000 tons.

After 10,000 tons of material is produced, the Contractor will provide the Department with an aggregate sample representing each stockpile and asphalt required for the mix design. The Contractor shall develop a preliminary mix design and submit the results to the department. This mix design is for informational purposes to assure the Contractor has produced specified material. The Department will develop the mix design for the project. The Contractor shall provide all of the information required for the JMF, except the stability of the mix. The mix design will be developed according to the Department's *Field Sampling and Testing Manual* and will meet the requirements specified in Section 409.04 B.

The Contractor will sample and test the aggregate according to the Department's *Field Sampling and Testing Manual*.

The Contractor will provide the Engineer with copies of the test results for each stockpile of aggregate that will be incorporated into the mix by noon of the following day the tests are completed. The test reports will include results for gradation, plastic index, fractured faces, lightweight pieces of aggregate and the bulk and apparent specific gravity.

During the first week of aggregate production, for each class of aggregate, as soon as the Contractor determines the aggregate is representative, and prior to the initial mix design, the Contractor shall obtain a 90-pound sample of each aggregate component. The Contractor shall split the samples under the observation of the Engineer. One-half of each aggregate sample will be submitted to the Engineer for testing. The Contractor and the Engineer will test the samples to determine the bulk (dry) and apparent specific gravity and the percent water absorption by dry weight of aggregate. The testing will be completed according to AASHTO T-84, T-85 and the Department's modified test procedures on file in the Materials and Research Laboratory in Bismarck, ND. One test will be performed for each 10,000 ton of each aggregate component produced. A minimum of two tests will be required for each aggregate component. Testing shall commence within 2 working days of sampling. Test results will be reported to each party as soon as they are available.

If the individual specific gravity values determined by the Contractor and the Department correlate within 0.040, the average of the Contractor's numbers will be used to calculate the absorption, fines to asphalt ratio, and voids in mineral aggregate (VMA). If the individual specific gravity values determined by the Contractor and NDDOT do not correlate within the allowable tolerance (0.040), or if the Contractor fails to supply an aggregate that meets the mix design criteria then:

1. The mix design will not be approved and mix production will not begin.

2. The Contractor has the option of running the test together with DOT personnel at the District Lab and use those results, or testing differences can be resolved according to the Department's resolution procedures on file in the Materials and Research Laboratory in Bismarck, ND.

If the Department's mix design meets the properties specified and the Department and the Contractor mutually agree it is necessary to adjust the aggregate production operation to produce an aggregate that will improve the mix design properties, the Department will negotiate an equitable adjustment with the Contractor to produce an aggregate that meets the desired mix design properties.

- B. Mix Design.** The mix design used will be a lab mix design developed by the Department or determined by the Contractor and approved by the Department. The mix design will be developed according to the NDDOT Mix Design Procedure as revised in October 1998. The mix design will be developed using the type, grade and source of asphalt that will be used on the project. The target value for each sieve for the mix design shall be the average of production samples multiplied by the percentage of material used in the blend proportion. The blended sample will be used for the mix design if the gradations obtained from the blended sample are within the tolerances listed in Table C when compared to the target values. The mix design will meet the following properties for the type of mix specified:

Mix Criteria	CLASS 27				CLASS 29				CLASS 31				CLASS 33			
	Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Blows to Marshall Plug	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Stability (lbs.) <sup>1</sup>	1200		1200		1500		1500		1650		1650		1800		1800	
Flow, 0.01 in.	8	18	8	18	8	18	8	18	8	16	8	16	8	16	8	16
Percent VMA <sup>2</sup>	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0
Fines/Asphalt Ratio <sup>3</sup>	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4

<sup>1</sup>Desired minimum value, the Materials and Research Engineer will evaluate the actual value determined in the mix design.

<sup>2</sup>Voids in Mineral Aggregate (VMA).

<sup>3</sup>Required Range, the fines/asphalt ratio shall be determined by dividing the percentage of material passing the #200 sieve by the percentage of effective asphalt added to the mix. The percentage of asphalt used will be as determined in the Mix Design at 4% air voids. The effective asphalt will be determined as follows: (The formula is as defined in Manual Series No. 2 published by the Asphalt Institute.)

$$AC_{\text{effec}} (\text{Mix Basis}) = \%AC - \left\{ \frac{\% \text{Absorbed AC by weight of aggregate}}{100} \times \% \text{Aggregate in mix} \right\}$$

Perform calculations to the nearest hundredth and round to the nearest tenth.

## 1. **NDDOT Developed Mix Design.**

The Contractor will provide the Engineer with an aggregate sample representing each stockpile as specified previously. A sample tag identifying the project number, pit location, and class of aggregate shall be attached to the sample. The total weight of the combined sample will be approximately 150 pounds and meet the gradation of the class of aggregate specified.

The Contractor will also provide eight one-quart cans of bitumen of the type and grade specified in the Plans. The bitumen will meet all requirements of Section 818 and will be from the supplier the Contractor uses for the project.

The Contractor will submit the aggregate sample, the blend proportions, the average production sample results, and the type, grade, AC specific gravity, and name of the supplier of the bitumen in writing with the submission of the samples. The aggregate and bitumen samples will be submitted a minimum of seven working days before the start of the planned paving operations.

If aggregate or asphalt is utilized from sources other than those initially submitted, the aggregate is processed using a different crusher, or if a different type or grade of asphalt is used, the Contractor shall notify the Engineer in writing five days before incorporating the material into the work. If the Engineer determines that a new mix design is required, the Contractor shall provide a sample of the material to the Engineer and allow the Department three working days to prepare a new mix design. If the Contractor fails to provide a timely sample, the Contractor shall cease operations and allow the Department three working days to prepare a new mix design.

The target value for each sieve for the mix design shall be the average of production samples multiplied by the percentage of material used in the blend proportion. NDDOT will blend the aggregate at the blend proportions specified by the contractor. The blended sample will be used for the mix design if the gradations obtained from the blended sample are within the tolerances listed in Table A when compared to the target values determined previously. If the aggregate is not within tolerance a mix design will not be developed.

## 2. **Contractor Developed Mix Design.**

After the Contractor has sufficient material produced to assure uniform production of each aggregate component, a mix design or series of mix designs shall be performed until a mix design is developed meeting all the requirements specified. The Contractor shall submit the completed mix design including all test data to the appropriate District Materials Laboratory.

The final mix design report shall be submitted using an Department-approved computer format. The Contractor shall also submit:

- a. Sufficient amounts of individual aggregate components and asphalt, the aggregate and asphalt will have the same properties as was used for the Contractor's mix design.
- b. Approximately 30 pounds of loose asphaltic concrete mixture, and

- c. Two sets of three Marshall specimens prepared and compacted at the percent AC recommended in the mix design,
- 1) One set compacted as per mix design procedure, and
  - 2) One set compacted after mix has been cooled to room temperature and then reheated to compaction temperature and compacted.

The Contractor's mix design will be reviewed within five working days.

If the Department's verification confirms the results of the Contractor's mix design are within the tolerances specified in Table C, the Contractor's mix design will be approved. If the Contractor's mix design is not approved, the Contractor shall submit another mix design. An approved mix design will be required prior to beginning production of hot bituminous pavement.

If aggregate or asphalt is utilized from sources other than those initially submitted, the aggregate is processed using a different crusher, or if a different type or grade of asphalt is used, the Contractor shall notify the Engineer in writing five days before incorporating the material into the work. If the Engineer determines that a new mix design is required, the Contractor will develop another mix design and submit it for approval with the same information as required for the initial mix design, before incorporating this material into the mixture. If the Contractor fails to submit an approved mix design and provide timely samples, the Contractor will cease operations until an approved mix design is developed.

The result of the mix design process is the Job Mix Formula (JMF), and will contain the following:

- 1) The percentage of aggregate passing each of the specified sieves.
- 2) The percent asphalt cement to be added to the mixture.
- 3) The target air voids will be 4%.
- 4) The maximum specific gravity of the mixture obtained in the laboratory.
- 5) The bulk specific gravity of the mixture obtained in the laboratory.
- 6) The percent VMA of the mixture obtained in the laboratory.
- 7) The stability of the mix.
- 8) The fines/asphalt ratio.
- 9) The asphalt film thickness.

### Determination of Surface Area

Sieve Analysis % Passing											
Sieve	5/8	1/2	3/8	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	
Combined Grading	***	***	***	***	***	***	***	***	***	***	
Coefficient				0.02	0.04	0.08	0.14	0.30	0.60	0.60	Total
Surface Area											

$$* \quad \text{Film Thickness } FT = \frac{(Pbe)(4885)}{(100)(SA)}$$

Where: Pb = asphalt cement, %, mixture basis  
 Pba = % AC absorbed by weight of aggregate  
 Ps = aggregate, % mixture basis  
 Pbe = effective asphalt content, %, mixture basis  
 FT = film thickness (Microns)  
 SA = surface area (ft<sup>2</sup>/lb)

\*\* The Dust/Effective asphalt ratio shall be determined by dividing the percentage of material passing the #200 sieve by the percentage of effective asphalt added to the mix. The percentage of asphalt used will be as determined in the Mix Design at 4% air voids.

The effective asphalt will be determined as follows: (The formula is as defined in Manual Series No. 2 published by the Asphalt Institute.)

$$Pbe = Pb - \frac{(Pba)(Ps)}{100}$$

\*\*\* The gradation used for calculating film thickness and dust/effective A.C. ratio will be the combined gradation results of the actual material used to run the mix design. Perform calculations to the nearest hundredth and round to the nearest tenth.

**(Sections C through N are specified in the respective sections of 408.04)**

O. **Quality Control Sampling and Testing.** During production of the bituminous mix, the Contractor will be required to perform random sampling and testing on the aggregate and bituminous mix as the mix is being produced and placed on the roadway. All test results will be provided to the Engineer by noon the following day.

The Contractor will sample and test the bituminous mix as outlined in the Department's *Field Sampling and Testing Manual*.

The Contractor will sample the aggregate from the cold feed and test the aggregate using the Department's sampling and testing procedures. The sieve analysis will be performed using all of the sieves required for the determination of the asphalt film thickness. The tests will be performed at the frequency specified in Table A below:

**TABLE A**  
**QUALITY CONTROL TESTING FREQUENCIES**

<b>Test</b>	<b>Frequency</b>
Gradation (use all sieves for Cl. specified)	1/1500 tons
Plastic Index <sup>1</sup>	3/10,000 tons
Lightweight pieces of aggregate <sup>1</sup>	3/10,000 tons
Fractured Faces <sup>1</sup>	3/10,000 tons
Maximum Sp. Gr. of Bit. Mix (Rice Method)	1/1500 tons
Bulk Sp. Gr. of Bit. Mix (Plugs) & Air Voids	1/1500 tons
% Asphalt Cement	1/1500 tons <sup>2</sup>

<sup>1</sup> The content of the lightweight pieces of aggregate, plastic index, and fractured faces of the aggregate will be determined by the average of test results from three random samples taken from the cold feed belt for each lot of 10,000 tons or fraction thereof. If all samples pass, only one of the three samples

taken will be tested until a sample fails; then the remaining two samples will be tested and averaged for the acceptance of that lot. The testing of three samples per lot will continue until all three samples pass, then one of the three samples will be tested from each lot.

<sup>2</sup>The Contractor will make random checks of the asphalt content each time a gradation test is taken under the observation of the Engineer. The random checks will be based on readings from the totalizers for the aggregate and the bitumen as outlined in the Department's Asphalt Content Determination Report.

The Contractor will split and identify all samples. The split samples will be retained by the Contractor for Independent Assurance testing by the District Materials Laboratory. The samples to be tested by the Contractor and the split samples given to the Engineer will be large enough to be split again, such that four samples are available for testing. The split samples of aggregate will be stored in a dry, protected location until picked up by the Engineer. The mix samples taken to determine the maximum specific gravity will be split after the sample has been allowed to cool.

When quality control samples indicate uniform results on Plastic Index, Lightweight Pieces of Aggregate, or Fractured Face Tests; and both parties are confident that future production will remain within the specifications, the Engineer, by written notice, may reduce the frequency of the tests.

1. **Control Limits.** The Contractor will maintain the air voids, within the allowable working ranges by adjusting the gradation or asphalt content within the allowable working ranges. The target values of the control sieves provided by the mix design (JMF) will be the target values for the control limits. The target value for the bitumen will be the target value set by the JMF. The field test results may vary from the JMF target values as shown in Table B.

**TABLE B  
ALLOWABLE WORKING RANGES**

Parameter	Single Test Control Limit	Moving Aerge Control Limit <sup>1</sup>
% Lightweight pieces of aggr.	Not more than the maximum specified	
% Fractured Faces	Not less than the minimum specified	
Plastic Index	Not more than the maximum specified	
1/2" & #4 Sieve	± 6	± 5
#30 sieve	± 5	± 4
#200 Sieve <sup>2</sup>	± 2.0	± 1.5
Asphalt Content	± 0.30	± 0.24
Air Voids (plugs)	2% to 6%	3% to 5%

<sup>1</sup>Average of last four tests

<sup>2</sup>Not to exceed the maximum specified.

2. **Corrective Action.** When a single-test control limit has been exceeded, the Contractor will immediately re-sample and retest. If the re-sample exceeds the control limits, corrective action will be instituted by the Contractor immediately. After the corrective action, the Contractor will immediately re-sample and retest. The corrective action will be documented.

Immediate shutdown will result when two consecutive tests exceed the single-test control limits for percent Lightweight pieces of aggregate, percent Fractured Faces, or Plastic Index. Operations will resume when the Engineer is satisfied that corrective action has been taken.



When the moving average values trend toward the moving-average control limits, the Contractor will take corrective action and increase the sampling and testing rate. The corrective action will be documented.

When the moving average of the control sieves or the bitumen exceeds the moving-average control limits, the Contractor may continue production if the air voids are within the control limits and the material passing the number 200 sieve does not exceed the maximum specified. The Contractor will take the necessary corrective action to produce mix based on the JMF or the Contractor may request that new target values be set if the production test results indicate adjustments to the target values are necessary. The Contractor may only make the changes requested with the approval of the Engineer.

When the moving average of the air voids exceeds the moving average control limit, the Contractor will immediately cease operations and take necessary corrective measures to get production back within the control limits. Quality control testing will resume as soon as the plant has started and operations are stabilized.

It will be the responsibility of the Contractor to shut down operations when the control limits are exceeded as specified. Failure to cease operations shall subject all material produced after exceeding the control limits to be considered unacceptable.

3. **Documentation.** The Contractor will maintain complete records of all process quality control tests and inspections. All test results and calculations will be recorded and documented on data sheets approved by the Department. Copies of the records will be furnished to the Engineer.

The Contractor will maintain standardized control charts at the field laboratory. Test results obtained by the Contractor will be recorded on the control chart immediately upon completion of the test. The following parameters will be recorded on the control chart:

- Gradation of the control sieves<sup>1</sup>
- Asphalt Content
- Maximum Specific Gravity
- Bulk Specific Gravity
- Percent Air Voids of field marshall plugs
- Daily average Air Voids percentage of the cores
- Average daily Density
- Calculated A.C. Film Thickness (Microns) (Informational only)
- Calculated Dust/Effective A.C. Ratio (Informational only)

<sup>1</sup> The control sieves are the 1/2", #4, #30, and #200 sieves.

The control charts will display the single-test control limits for each test parameter, the individual test results, the moving average control limits, and the moving average of the last four tests. The moving average results and control limits, and the single tests and control limits will be color coded for easy distinction.

The control charts will be displayed at the field laboratory and will be accessible at all times for review by the Engineer.

- P. **Verification Testing.** The Engineer will conduct verification tests on independent samples. Cold feed belt, bitumen tank samples and coring shall be sampled by the Contractor under the observation of the Engineer. The Engineer will test at an increased rate during the first lot of production to determine the accuracy of the quality control testing. Frequencies for verification testing are located in Appendix G of the Department's Sampling and Testing Manual. Test results performed by the Engineer will be available to the Contractor.

The Engineer will observe the Contractor make the random checks for Asphalt Content as specified in Section 409.04 O.

Samples may be taken and tested by the Department any time the material appears defective or where the Engineer determines that a change in the process or production has occurred.

- Q. **Independent Assurance Testing.** The Contractor's quality control technician will test the aggregate and bituminous mix as specified and provide split samples to the Department for independent assurance testing. The Department will test the aggregate and bituminous mix at random times throughout the project at the frequencies defined in the Department's Sampling and Testing Manual. Test results will correlate within the acceptable tolerances specified in Table C.

**TABLE C**  
**ACCEPTABLE TOLERANCES FOR INDEPENDENT ASSURANCE**

5/8" – #4 sieve	± 5%
#30 sieve	± 3%
#200 sieve	± 1.5%
Plastic Index	± 2%
Fractured Faces	± 5%
Air Voids	± 1.0%
Max. Sp. Gr.	± 0.020
Lightweight pieces of aggr.	± 1%
Bulk Specific Gravity (dry), each aggr. fraction <sup>1</sup>	± 0.040
Apparent Specific Gravity, each aggr. fraction <sup>1</sup>	± 0.040

<sup>1</sup> These items are not final mixture acceptance items.

#### **409.05 ACCEPTANCE.**

The aggregate gradation pay factor in Section 409.05 A.1 and the bitumen uniformity requirements in Section 409.05 B.2 will not apply when the total plan quantity of hot bituminous pavement is 4,000 tons or less. When the total plan quantity of hot bitumi-

nous pavement is 4,000 tons or less the material will be accepted according to Section 105.07.

#### A. Aggregate.

1. **Gradation.** Aggregate will be sampled and tested in lot sizes equal to the number of tons placed each production day. The aggregate gradation specified will be the basis of acceptance.

The Contractor shall obtain all aggregate samples at random times determined by the Engineer. The samples shall be taken from the cold feed belt according to AASHTO T-2, Section 4.3.1 or 4.3.2. The sample shall be split into two representative samples, numbered and bagged by the Contractor under the observation of the Engineer. The untested half of the sample will be retained by the Engineer for 24 hours after the test results are made known to the Contractor. Either party may request that the second half of the sample be tested within this 24 hour time frame. The test results from this retest shall replace the test values of the initial test.

One aggregate sample will be taken for each 1,500 ton of mix produced. Payment for the mix represented by the samples will be based on the uniformity of the test results.

If any two consecutive tests vary from the JMF gradation target value set for each sieve by more than the tolerances listed below, the pay factor for the full days production will be the lowest pay factor determined from the following formula, unless the daily air voids of the marshall plugs as determined in Section 409.05 C.1 are between 3 and 5% and the aggregate gradation for each sieve is not outside the gradation band for the class of aggregate specified, then the pay factor will be 100%.

$$\text{Pay Factor} = \frac{100 - \text{Deviation from the Target Range}^*}{100}$$

\* Target Range = target value + or – the acceptable tolerance value

Acceptance of the aggregate will be based on the target values for the control sieves and the allowable working range for the single test control limit as shown in Section 409.04 O.1 Table B.

If the average daily air voids of the marshall plugs are not between 3 and 5% and the material fails to meet the specifications for 2 consecutive lots, the Contractor shall not incorporate any additional material into the work until the Engineer is satisfied that the Contractor is taking the necessary corrective action to meet the Specifications.

2. **Additional Aggregate Tests.** Aggregate samples to determine shale content, plasticity index, fractured faces, and L. A. Abrasion loss will be taken by the Contractor, under the observation of the Engineer, before the addition of bitumen to the mix.

The shale content and plasticity index of the aggregate will be determined by the average of test results from 3 random samples taken from the cold feed

belt from each lot of 10,000 tons or fraction thereof. The samples will be tested and the material will be accepted if the average of the 3 samples meets the specified requirements. If each of the samples is within the specified limits, only one of the 3 samples will be tested from each subsequent lot. If at any time the sample tested does not meet the specified requirements, the remaining 2 samples will be tested. The average of these 3 samples will then be used to determine acceptance of the material. The testing of 3 samples per lot will continue until all 3 samples are within the specified limits, then only one of the 3 samples will be tested from each subsequent lot. If the average exceeds the specified maximum for shale content, the unit price for the bituminous mixture will be adjusted according to Section 409.07 B. If the average fails to meet the specified requirements for plasticity, the material will be rejected, unless the Construction Engineer elects to accept it under Section 105.07.

The L. A. Abrasion loss percentage of aggregate will be determined on the basis of one composite aggregate sample taken and tested during the beginning of the aggregate stockpiling. If this percentage exceeds the maximum allowable loss, the material will not be accepted.

The percentage of fractured faces for coarse aggregates will be determined by the average of test results from 3 random samples taken from the cold feed belt for each lot of 10,000 tons of bituminous mixture produced. The samples will be tested and the material will be accepted if the average of the three samples meets the specified requirements. If each of the samples is within the specified limits, only one of the three samples will be tested from each subsequent lot. If at any time the sample tested does not meet the specified requirements, the remaining two samples will be tested. The average of these three samples will then be used to determine acceptance of the material. The testing of three samples per lot will continue until all three samples are within the specified limits, then only one of the three samples will be tested from each subsequent lot. If the average fails to meet the specified requirements, the material will be rejected unless the Construction Engineer elects to accept it under Section 105.07.

- B. Bitumen Content.** The required bitumen content, or target percentage, will be designated by the Engineer.

The quantity of bitumen used and paid for from each lot will be determined by the use of daily oil cutoffs following the procedures outlined on the Mix Bitumen Cutoff Report. A lot shall be defined as the amount of bitumen used each production day.

The pay factor for the hot bituminous pavement, adjusted for bitumen content, will be the lowest pay factor determined by both of the following methods:

1. **Average.** If the daily cutoff, as determined on the Mix Bitumen Cutoff Report, deviates from the target percentage set by the Engineer by more than 0.24 percentage points the pay factor will be determined from the following table:

**BITUMEN CONTENT**

<b>Pay Factor</b>	<b>Deviation from Target in Percentage Points</b>
1.00	.00–.24
.98	.25–.29
.95	.30–.34
.92	.35–.39
*	.40 & Over

\*The Construction Engineer will determine the pay factor according to Section 105.07.

2. **Uniformity.** The Engineer will check the asphalt content each time an aggregate sample is taken. The checks will be based on readings from the totalizers for the aggregate and the bitumen as outlined in the Asphalt Content Determination Report. If the asphalt content from any random reading varies from the daily average of the readings by more than 0.24 percentage points, the pay factor for the hot bituminous material will be adjusted according to the following formula:

$$\text{Pay Factor} = \frac{100 - [20 (\text{Deviation} - 0.24)^*]}{100}$$

\*Deviation from the average daily asphalt content.

**C. Compaction.**

1. **Testing.** The compaction of the mixture will be accepted in lot sizes equal to the number of tons placed each production day. The density of the pavement will be determined from cores obtained by the Contractor, as specified in Section 409.05 C.2.

Each subplot will be one paver width wide, excluding the shoulders, 2,000 feet long, and of the depth specified for the pavement course. If the partial subplot remaining at the end of a production day is 1,000 feet in length or longer, it will be considered a separate subplot. If it is less than 1,000 feet long, it will be included in the last complete subplot. If the total day's production is less than 2,000 feet long (one paver width wide), that production will be considered a lot.

The mean density of the mainline pavement placed each production day will be the average of the densities of all of that day's sublots. In addition to testing randomly selected locations, the Engineer reserves the right to direct the testing of any areas which appear defective. Defective areas will be rejected unless the Engineer elects to accept it under Section 105.07.

The Contractor, under the observation of the Engineer, shall:

- a. Obtain mix samples from behind the paver at random times specified by the Engineer. One sample shall be taken each time an aggregate sample is taken; and
- b. Compact three Marshall specimens with each sample taken to determine the field Marshall density. The number of blows applied to the Marshall

specimens shall be 50, unless otherwise specified, and the temperature of the mix shall be 270 plus or minus 5°F.; and

c. Determine the Maximum Theoretical Density of each sample taken.

The methods used to obtain the samples, compact the Marshall specimens and determine the Maximum Theoretical Density shall be as outlined in the Department's *Field Sampling and Testing Manual*.

2. **Contractor Coring.** The Contractor shall take two cores in each subplot at a random location determined by the Engineer and under the observation of the Engineer. After coring and sawing, the cores shall be handed over to the Engineer. The cores shall be taken adjacent to each other and the average of the two cores shall be used for determining the density of the subplot.

The Contractor shall take two additional full-depth cores per mile, with one location in each lane, for the District Materials Coordinator to use as an independent assurance test. The District Materials Coordinator will determine the locations of these cores. The cores shall be marked and delivered to the District Materials Laboratory. The cores shall not be sawed by the Contractor.

The coring machine shall cut a cylindrical sample in the compacted asphalt lift without disturbing the density of the sample. The core samples shall be 4 to 6 inches in diameter. The masonry saw shall cut the core sample so only the compacted layer to be tested is removed; and the core is in a condition suitable for testing.

Coring of each day's paving shall be completed no later than the next working day following the placement of the lift. Cores shall be taken through the full depth of the in-place asphalt pavement. The surface of the outside of the cores shall be smooth with no distortion of the cylindrical shape or displacement of the aggregate particles. A masonry saw shall be used to remove the compacted layer from the full-depth core without damaging the newly placed asphalt material.

The Contractor shall fill all holes remaining in the surface of the roadway with bituminous material and compact the material as directed by the Engineer. Each core shall be numbered or lettered to identify the location from which the core was taken. The marking system shall meet the approval of the Engineer.

The Contractor may elect to take a check sample, at the Contractor's expense, whenever the average density of a set of cores is 89% or less than the Theoretical Maximum Density. A check sample shall be a set of cores taken within 2 feet of the location of the failing set of cores. The average density of the check sample cores will be the result used to determine the Unit Price of the hot bituminous pavement.

Retests and additional tests will not be taken or paid for unless approved by, or directed by, the Engineer.

The Contractor shall control traffic according to the traffic control plan to ensure the safety of the coring crew and the traveling public. The Engineer may

alter these requirements depending on the location of the coring operation in respect to the existing traffic control zone, and in situations where traffic is being controlled by a pilot car and/or flaggers. Coring operations shall not take place adjacent to the paver to avoid blocking traffic.

### 3. **Compaction Payment Schedule.**

Acceptance of mainline pavement placed on any production day will be based on the average density of the pavement compared to the daily average maximum theoretical density (MTD) determined for each lot of pavement placed. The average density of the field cores shall be at least 91% of the daily average MTD. Each individual subplot shall have an average density of at least 89% of the daily average MTD. If the average density of the field cores is less than 91% of the daily average MTD or any subplot is less than 89% of the daily average MTD the Unit Price of the hot bituminous pavement will be adjusted according to the following tables:

#### **PAVEMENT DENSITY ADJUSTMENT OF UNIT BID PRICE PER LOT**

<b>Pay Factor A</b>	<b>Average Pavement Density</b>
1.00	91% or greater
.99	90.0% – 90.9%
.975	89.0% – 89.9%
.95	88.0% – 88.9%
.925	87.0% – 87.9%
*	Less than 87.0%
<b>Pay Factor B</b>	<b>Lowest Density of any Sublot</b>
1.00	89% or greater
.99	88.0% – 88.9%
.98	87.0% – 87.9%
.97	86.0% – 86.9%
.96	85.0% – 85.9%
*	Less than 85.0%

\*The Engineer will determine whether the material may remain in place. The Pay Factor for the material allowed to remain in place shall be .70 for Pay Factor A and .80 for Pay Factor B.

The density of the field cores will be determined according to the Department's Field Sampling and Testing Manual. The Total Pay Factor will be the product of the pay factor for the average pavement density and the lowest subplot.

$$\text{TOTAL PAY FACTOR} = (\text{PAY FACTOR A}) \times (\text{PAY FACTOR B})$$

### D. **General.**

The Contractor's Quality Control test results will be used for acceptance if they are within acceptable tolerances. A table for comparison of Verification Testing and Quality Control Testing is located in Appendix G of the Department's Sampling and Testing Manual.

The Contractor's Quality Control Program will be conducted by qualified personnel as outlined in the applicable NDDOT's Transportation Technician Qualification Program. The data from the QC and verification testing will be compared using statistical analysis. The F test will be used to compare the standard deviations. The T test will be used to compare the mean values.

If the results of the NDDOT's verification sampling and testing program do not agree with the QC sampling and testing as performed by the Contractor, the NDDOT, or its Representative, will conduct a review of the quality control and verification procedures, calculations, and equipment to determine the cause of discrepancy.

**E. Dispute Resolution Program.**

If the cause of disagreement between the verification and quality control results cannot be determined, the dispute resolution process as outlined in the NDDOT Field Sampling and Testing Manual Appendix G will be implemented.

**409.06 METHOD OF MEASUREMENT.**

The estimated quantities provided may be adjusted by the Engineer in the field. Any increase or decrease in the quantities used shall not be a basis for renegotiation in the price bid for these items.

- A. **Hot Bituminous Pavement.** Hot Bituminous Pavement will be measured by the Ton or Square Yard according to Section 109. Batch weights will not be permitted as a method of measurement unless the plant is equipped with an automatic batching and weighing system with an automatic printer system which prints the weights of each batch and issues a weigh ticket for each load. The tonnage will be the weight used in the accepted pavement and no deduction will be made for the weight of bitumen used in the mixture.
- B. **Bitumen.** Bitumen will be measured according to Section 109 and the quantity of bitumen will be the number of Tons or Gallons used in the accepted work.
- C. **Cored Sample.** Each individual cored sample that is removed in the required condition will be measured as a unit. The work vehicle, coring machine, masonry saw, and shadow vehicle will not be measured for payment, but will be included in the measurement of the cored sample.
- D. **Testing.** All cost incurred for the Quality Control Testing, and contractor developed mix design when specified on the plans, will be measured and paid at the unit price per ton for testing.

**409.07 BASIS OF PAYMENT.**

Payment will be made at the Contract Unit Price for the following:

<b>Pay Item</b>	<b>Pay Unit</b>
Hot Bituminous Pavement QC/QA	Ton
Asphalt Cement	Ton or Gallon
Cored Sample	Each
Testing	Ton



This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

When price adjustments are required for failing material or patching, payment will be made as follows:

- A. Determination of the payment adjustment of a lot of bituminous mixture will be made by successively multiplying the Contract Unit Price per Ton of the bid item by the applicable pay factors as determined in Sections 409.05 A, 409.05 B, and 409.05 C.
- B. When the average of the test results specified in Section 409.05 A.2 shows a larger shale content than the maximum allowable specified, the following deduction from the Bid Price for the bituminous mixture item will be made:

One percent reduction in unit price for each 0.2% above the maximum allowable percentage. If the percentage of shale exceeds the allowable limits by 2% or more, the material will be rejected unless the Engineer elects to accept it under Section 105.07.

This reduction will apply to lots of 10,000 tons, and will be applied independently of Section 409.05 A.1

- C. Material for patching or leveling of an existing bituminous surface constructed under a previous Contract shall be obtained from the tonnage provided in the basis of estimate and will be paid according to Section 408.07 C.

## SECTION 410 HOT BITUMINOUS PAVEMENT SUPERPAVE VOLUMETRIC MIX DESIGN

### 410.01 DESCRIPTION.

This work shall consist of constructing one or more courses of bituminous pavement on a prepared surface for Quality Control/Quality Assurance (QC/QA) projects. The Contractor shall be responsible for process control, and shall perform the necessary testing to control the quality of the work. When specified on the plans the contractor shall develop a mix design.

### 410.02 MATERIALS.

- A. **Bitumen.** The bitumen shall meet Section 818 and will be of the type and grade specified in the Contract. Bitumen will be accepted as outlined in the Combined State Binder Group agreement for North Dakota. Samples will be obtained by the Contractor under the observation of the Engineer, and immediately handed over to the Engineer for shipping and testing.